

Do students behave differently in synchronous versus asynchronous courses? A case study of dental hygiene students

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Running Title: Students' behaviour in online courses

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Conflict of interest: The authors of this study declared no conflict of interest.

Ethics Approval: This study has been approved by the Research Ethics Board of the University of Alberta (ID: Pro00157087).

Funding: No funding

ABSTRACT

Introduction: Studies comparing learning and learning modalities examine distinct student groups, introducing variability in baseline characteristics such as prior knowledge, motivation, and learning style. Our study evaluates whether students demonstrate different patterns of engagement in synchronous versus asynchronous courses, and whether delivery method influences outcomes within the same cohort of dental hygiene (DH) students. **Description of case:** 27 DH students enrolled in both OBIOL 202 (online asynchronous) and OBIOL 203 (online synchronous) were included in this study. Students' scores on the final exams and engagement data from the learning management system (LMS) were analyzed, revealing no significant effect of the course delivery method on students' engagement and academic performance. **Discussion and conclusion:** Students' behaviors on an online course are likely driven by their motivation and learning patterns, with limited influence from the teaching modality. Further studies can explore students' motivation and learning styles across different modalities within a course.

Keywords: education; educational activities; educational technique; learning; teaching; teaching method

CDHA Research Agenda category: capacity building of the dental hygiene profession

PRACTICAL IMPLICATIONS OF THIS RESEARCH

- Instructors may want to structure courses to ensure consistent interactions with the material.

- Soft skills, such as time management and discipline, should be fostered to increase the likelihood of academic success. These skills are also invaluable in a clinic situation where appointments with patients are time limited.
- Students who infrequently or irregularly access course materials may benefit from early interventions to increase their likelihood of success.

CJDH In Press

INTRODUCTION

The year 2020 marked an extraordinary turning point, as the COVID-19 pandemic disrupted life worldwide and compelled educational institutions to rapidly adopt distance teaching, variously known as online learning, e-learning, or virtual classrooms.¹ While initially a necessity, this shift has persisted beyond the pandemic, fueling the global expansion and popularity of online learning in higher education, especially in health professionals' education.² Over time, online learning has diversified into multiple formats, including synchronous and asynchronous instruction, as well as self-paced and self-directed approaches.³

Plenty of research has been published in recent years comparing online and in-class learning, yielding mixed results. Online learners were found to achieve lower average grades compared to their in-person counterparts in psychology⁴ and biostatistics.⁵ On the other hand, students' academic performance was found to be significantly higher during e-learning compared to face-to-face classes in pharmacology, theoretical semiology, and pathology.⁶ Research comparing different online learning formats is also abundant, reporting equal satisfaction of medical students with synchronous versus asynchronous online learning,^{7,8} reduced cognitive load,⁷ and higher examination scores⁹ with synchronous delivery compared to asynchronous delivery.

Most studies comparing learning platforms and delivery methods are designed as randomized controlled trials¹⁰, quasi-experimental studies,^{4,11} or retrospective analyses.¹² In a randomized controlled trial, participants are randomly assigned to an intervention group or a control group (e.g., online vs. in-person classes) to evaluate the effectiveness of a specific intervention, such as delivery method, on student performance. A quasi-experimental design, by contrast, does not involve randomization; instead, it compares outcomes between groups of

students already enrolled in different delivery formats. Retrospective studies examine outcomes by comparing a current group of students with a previous cohort who experienced a different delivery method.¹³ In all cases, comparisons are made between two different groups of students. Studies exploring the effect of two different delivery methods on the same groups of students are scarce.

In this context, our study aimed to evaluate whether students exhibit different engagement (or online behaviour) in response to synchronous and asynchronous courses and if different delivery methods have different outcomes on the same group of dental hygiene students. Our specific research questions are:

1. Do dental hygiene students show different learning management system (LMS) interactions in synchronous compared to asynchronous online courses?
2. Do synchronous and asynchronous online courses have different outcomes on the same group of students?

CASE DESCRIPTION

A descriptive study design, which aims to systematically describe a population, situation, or phenomenon without identifying the underlying cause, was used for this study.^{14,15} We examined student engagement and academic achievements in two different learning environments: synchronous and asynchronous online. The University of Alberta Research Ethics Board (REB 2) reviewed and approved this study (ID: Pro00157087). The Dental Hygiene (DH) program at the University of Alberta offers an oral biology course (OBIOL 202) in an asynchronous online format to second-year DH students. In the Winter semester of 2024, 47 students enrolled in the 15-week

course. Two vodcast lectures were posted on the Moodle-based LMS each week, and the specific weekdays and times were set aside on students' calendars as study time for this asynchronous course. From the same cohort of DH students, some who need additional credits for a foundational biochemistry course are enrolled in the biochemistry course survey (OBIOL 203), also offered in the Winter term but in a synchronous online format. In the winter of 2024, 27 second-year DH students enrolled in OBIOL 203. Both courses were held on weekdays, in the morning, in back-to-back hours, and were taught by the same instructors (Figure 1).

To evaluate students' engagement and performance in two different courses, 27 second-year DH students enrolled in both OBIOL 202 and OBIOL 203 during the winter of 2024 were identified. Student performance on final exams and their engagement with learning materials were collected from the LMS. Descriptive statistics were used to analyze the data in Microsoft Excel.

RESULTS

Students' engagement patterns with the synchronous versus asynchronous course

The number of interactions with the weekly course materials was plotted over the course timeline. The synchronous OBIOL 203 has three non-cumulative exams, while the asynchronous OBIOL 202 has two non-cumulative exams. For both courses, a sharp increase in students' interactions with the course materials was observed during the exam week or the week before the exam (Figure 2).

When students' engagement was analyzed in a week-by-week manner and compared between the two courses, a consistent and common pattern was observed: students typically engage with the material twice, once during the week of its release and again either shortly before or during the

exam period. The total interaction during the exam period exceeds the assigned week of the course content (Figure 3).

Students' engagement with course materials was analyzed separately for the top five (18.5 percentile) and bottom five (18.5 percentile) students in both courses. In the online synchronous OBIOL 203 course, both high- and low-ranked students showed a general pattern of fewer, but regular interactions during the week, with an increase in interactions around exam time. However, the total number of interactions of the top-ranked students were higher than those of the low-ranked students in the same course (Figure 4A, 4B). A different pattern was observed in the asynchronous OBIOL 202 course, where the top-ranked students exhibited consistent low-level interactions with course materials throughout the week and increased activity around exam times and reading week. In contrast, low-ranked students in the same course had infrequent weekly interactions, mostly recorded around the two exams and reading week (Figure 4C, 4D).

Students' academic performance in the synchronous versus asynchronous course

The average score of the 27 students in the OBIOL 202 (asynchronous) course final exam (77%) was not significantly different from that of the OBIOL 203 (synchronous) course (80.3%), ($p = 0.127$) (Figure 5A). The performance of the top-ranked and the bottom-ranked students was also not significantly different between the courses (Figure 5B, 5C).

DISCUSSION

Our study examined the LMS interaction of the same group of students across two different online course delivery methods: synchronous and asynchronous. The results indicated that, regardless of delivery format, students demonstrated similar interaction patterns with weekly course materials, showing relatively low engagement during regular weeks but increased activity around exam periods (Figure 2, Figure 3). This suggests the likelihood that students' behaviors are driven by intrinsic motivation or learning patterns, with limited influence from the teaching modality. Intrinsic motivation is defined as the energizing behavior that comes from within an individual and develops due to an inherent interest in the activity.¹⁶ Wu et al.¹⁷ reported that both intrinsic and extrinsic motivations exert significant indirect effects on medical students' learning engagement and academic performance. There is also a growing call for the adoption of innovative teaching strategies aimed at strengthening intrinsic motivation among the emerging generation of healthcare students.¹⁶ Studies also suggest that for success in online education, besides cognitive engagement with the learning materials, emotional engagement is also equally important, which includes factors like motivation to participate, self-worth, and satisfaction with their achievements.¹⁸⁻²⁰ In a recent study, Zheng et al.²¹ reported a relationship between students' interactions with educational videos and academic performance. Among high-performing students of the class, Zheng et al.²¹ identified a behavioural pattern that reflects students' deep thinking and information searching while watching the video, suggesting enhanced cognitive engagement compared to the low-performing students.

To get a deeper understanding of students' behaviour and engagement patterns, we analyzed the interaction of top and bottom-ranked students in both courses. We found that the top-ranked students maintained a regular weekly interaction with the course materials, which increased during the reading weeks. The bottom-ranked students, on the other hand, had very low weekly

interactions in the synchronous course and scarce interactions in the asynchronous course. Recent studies show that, in addition to the quantity of engagement, the timing of engagement is also an important predictor of student success.²²⁻²³ Timing of engagement, which refers to both how early and how consistently students engage with the content,²² was lacking in the low-ranked students, especially in the asynchronous course.

The group of students in our study showed no significant differences in their academic performance between synchronous and asynchronous courses. This outcome is expected given the similar student-engagement patterns in both course types. Although the bottom-ranked students in the synchronous OBIOL 203 course showed some low interactions throughout the week compared to the asynchronous course (Figure 4), it did not result in any higher scores in the course final exam (Figure 5C). The increased interaction observed in the synchronous course is likely due to the weekly attendance in the classes where they accessed course materials.

While reinforcing the well-established link between the regularity of students' engagement with learning materials and academic success,²² our findings indicate that the type of online delivery method has limited influence on students' engagement and academic performance. As effective learning and student engagement can occur in either format, educators should focus on fostering students' intrinsic motivation and improving instructional quality, rather than focusing on the mode of online delivery. Educators can also leverage the flexibility of asynchronous teaching without fear of sacrificing students' engagement. Further studies, however, are needed to explore students' sources of intrinsic motivation and learning behaviour.

Study limitations

We acknowledge several limitations of this study. It focused on a single course within a dental hygiene program, which may restrict how widely the findings can be applied. No demographic data was gathered. Engagement, in the form of students' interaction with the learning materials, was the only type of engagement data included in this study. The courses did not have discussion forums, and students' interactions in the live chat in the online synchronous course were not recorded. For this reason, this study could not include other forms of engagement data, such as participation in the discussion forum or interaction with the instructor or peers. The LMS only showed when interactions occurred with the materials but did not include the total time spent on that engagement. However, this study examines the effect of two delivery methods within the same group, offering several advantages. For example, the use of the same student group controls to account for variability in baseline characteristics, such as prior knowledge, motivation, or learning style. Furthermore, by eliminating between-group differences, our study design allows more accurate detection of differences attributable solely to the delivery method.¹³

CONCLUSION

Our study shows no significant effect of the delivery method of an online course on students' engagement with the learning materials and academic performance. Findings from this study can guide educators to prioritize flexibility, accessibility, and learner needs when selecting online teaching approaches rather than assuming one modality is inherently superior.

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Figures and Tables

Figure 1. A schematic representation of the study design. The Dental Hygiene (DH) program offers an oral biology course (OBIOL 202) in an asynchronous online format to second-year DH students. In the Winter semester of 2024, 47 students were enrolled in the course. From the same cohort, some students who needed additional credits for biochemistry were enrolled in the biochemistry course survey course (OBIOL 203), also offered in the Winter term but in a synchronous online format. In the winter of 2024, 27 second-year DH students enrolled in OBIOL 203. Both courses were held in the same term, on the same weekdays, and were taught by the same instructor.

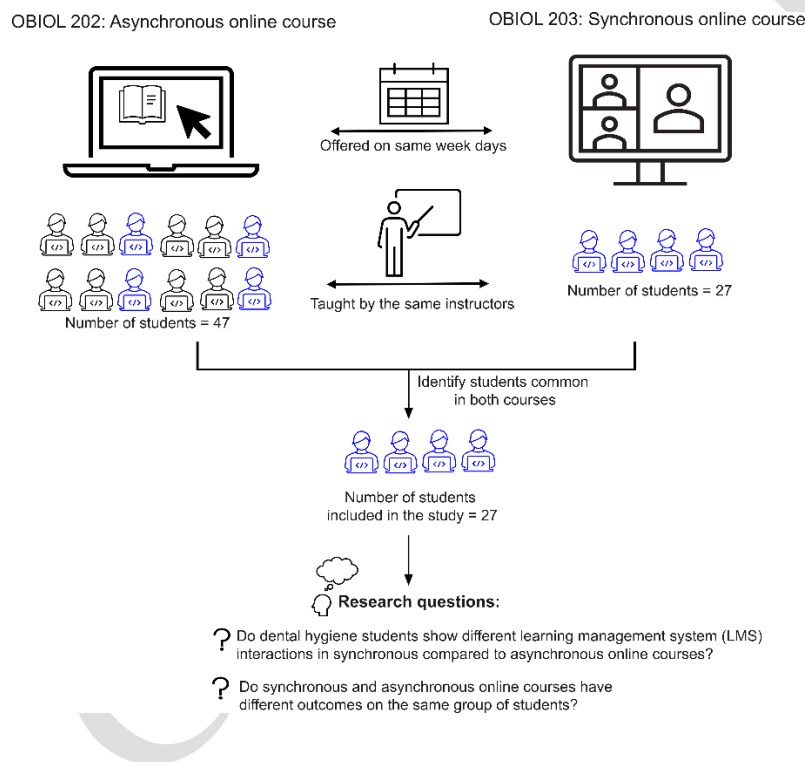


Figure 2. Students' engagement with the weekly course materials posted in the Learning Management System (LMS). The engagement data, in the form of interaction with the learning content, were collected from the LMS.

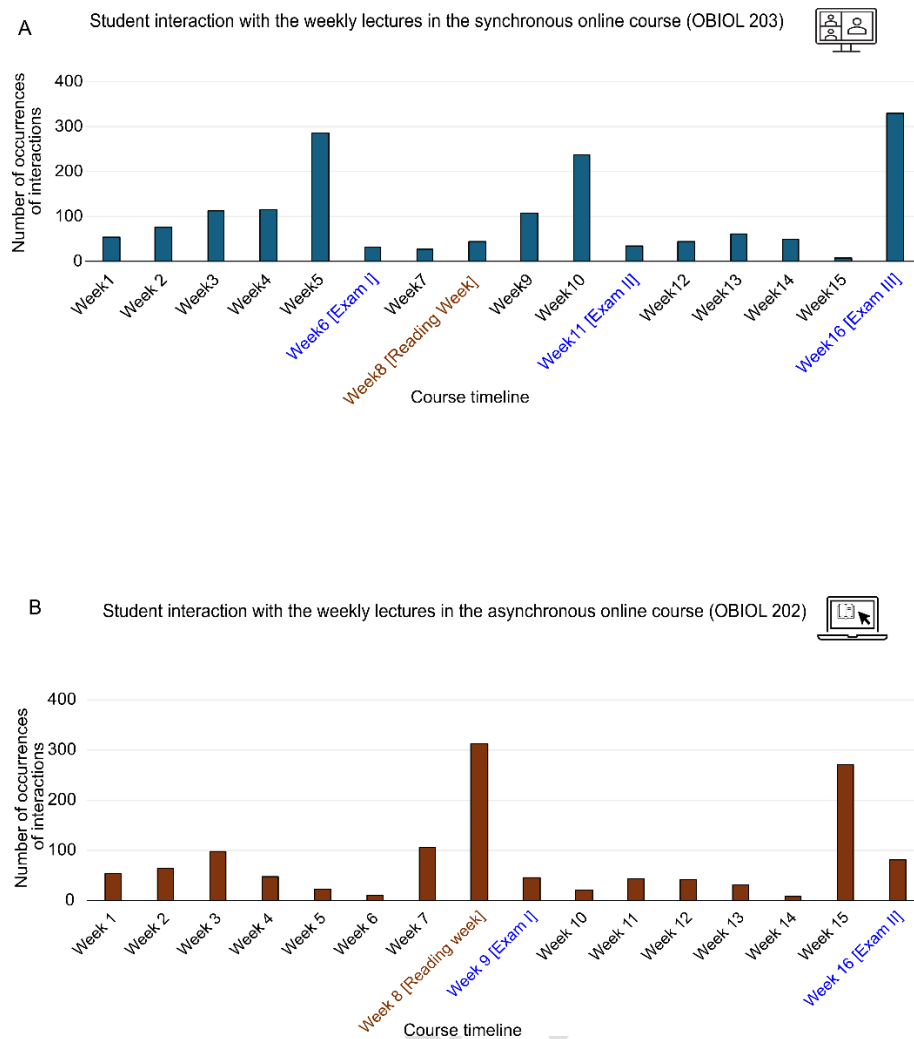


Figure 3. Patterns of student engagement across weekly course materials. Students' engagement was analyzed in a week-by-week manner and compared between the synchronous OBIOL 203 and asynchronous OBIOL 202 courses. The engagement data, in the form of interaction with the learning content, was collected from the Learning Management System (LMS).

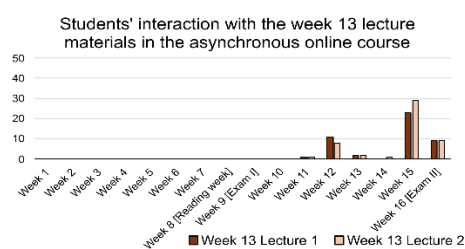
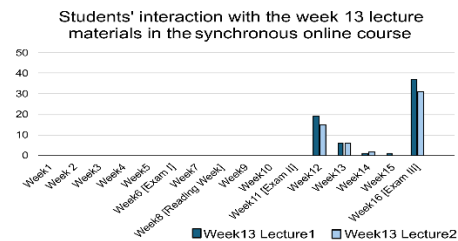
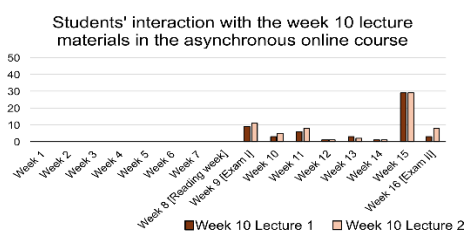
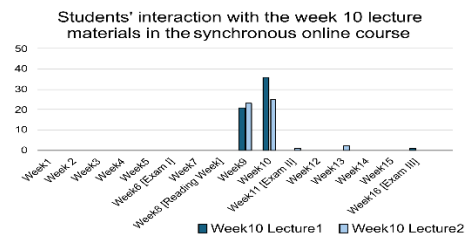
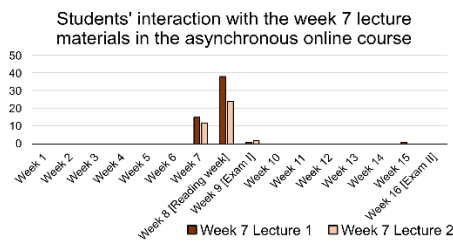
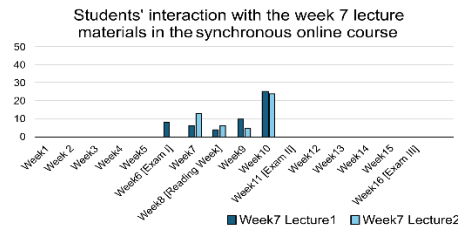
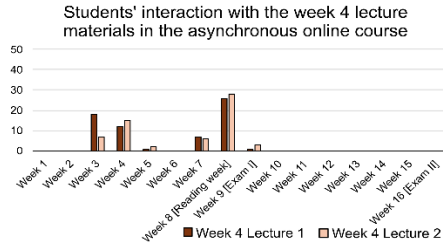
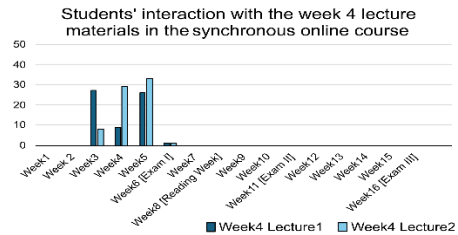
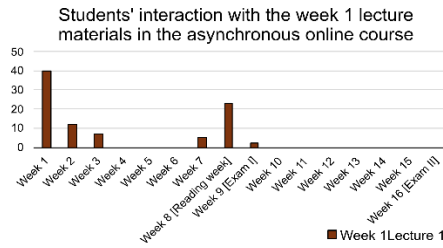
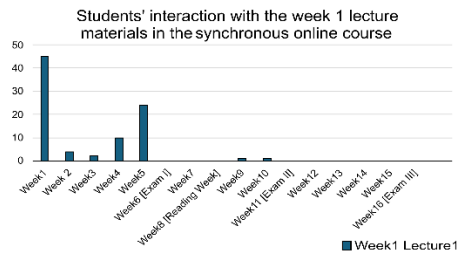


Figure 4. Student-specific engagement with the weekly course materials. The interaction patterns with the weekly course materials were compared between the top five (18.5th percentile) and bottom five (18.5th percentile) students in OBIOL 202 (asynchronous) and OBIOL 203 (synchronous) courses.

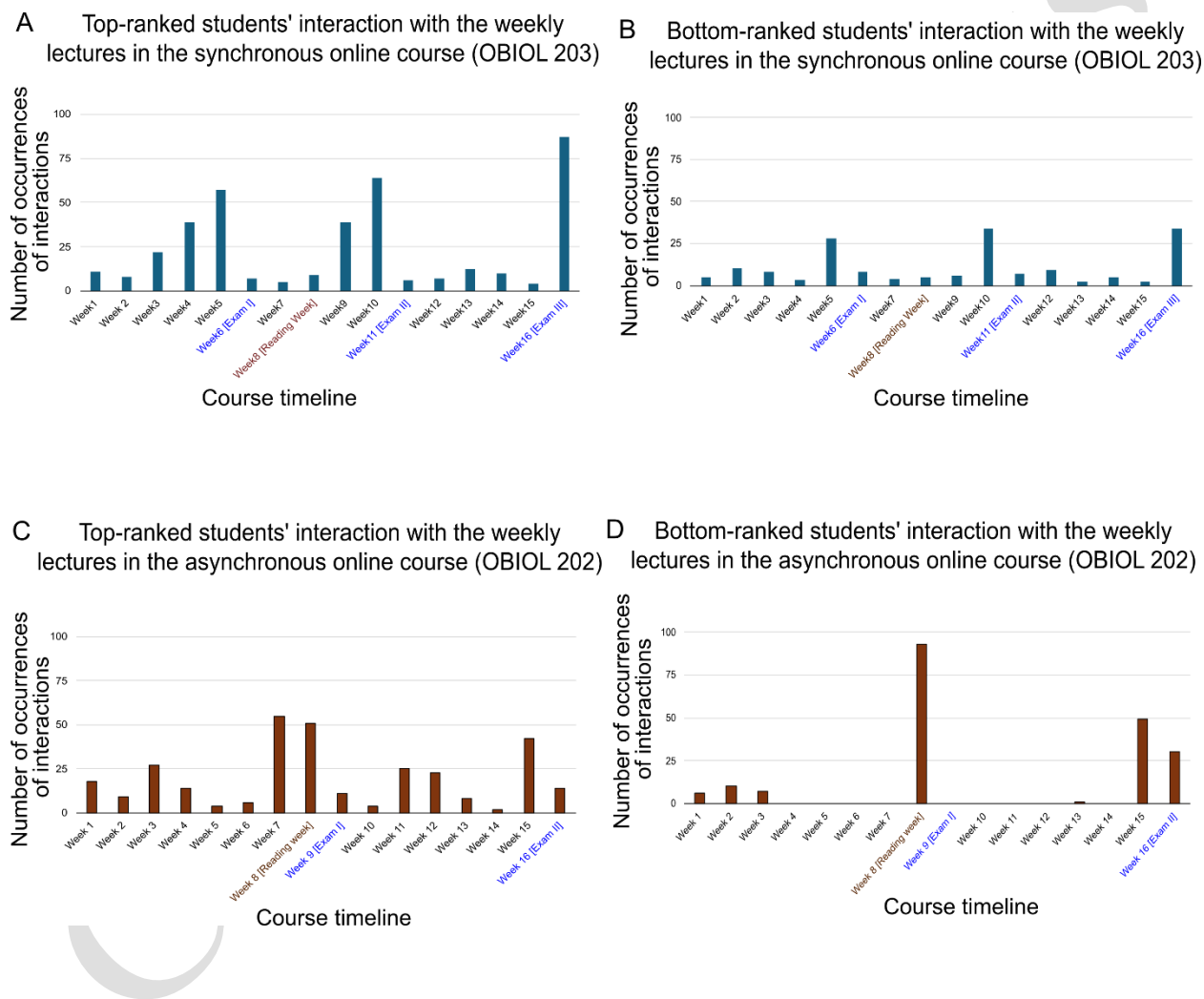
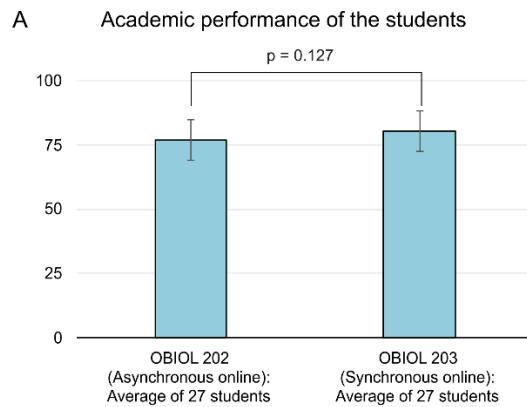
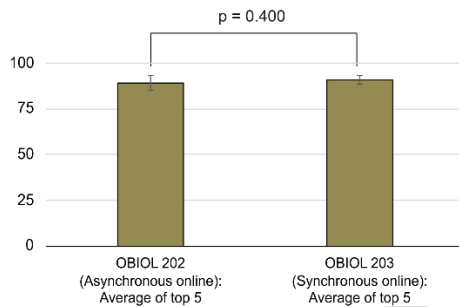


Figure 5. Students' academic performance in the synchronous versus asynchronous course. The average final exam score of the 27 students was compared between the OBIOL 202 (asynchronous) and the OBIOL 203 (synchronous) courses (A). The performance of the top-ranked (B) and the

bottom-ranked (C) students was also compared. Statistical analyses were conducted using two-tailed t-tests, with significance set at $p \leq 0.05$, using Microsoft Excel.



B Academic performance of top 5 students



C Academic performance of bottom 5 students

